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(54) [Title of the Invention]

DISPLAY DEVICE AND DISPLAY METHOD

(57) [Abstract]

[Problem to be solved] The object of the present invention is to provide a display device having a low electric power consumption, a high contrast ratio and a wide dynamic range.

[Solution] By changing an electric power supplied to a light source according to an image signal, the light emitted from the light source itself can be made darker for a dark screen, and can be made brighter for a bright screen. As a result, the contrast ratio for a displayed image can be improved, and electric power consumption can be reduced. While at the same time, the use life of a lamp can be extended. Further, while

the power supplied to the lamp is changed, the strength of an image signal supplied to a display panel is also changed so that a display screen darkens when the power supplied to the lamp is greater than a constant power, or brightens when the power is smaller. Therefore, it is possible to prevent changes in the brightness of the lamp that appear unnatural on the display screen.

[Claims:]

[Claim 1] A display device for displaying a predetermined picture image in accordance with an externally input image signal, comprising:

a light source;

a display panel for attenuating light supplied from the light source and for outputting the attenuated light;

an electric source for the light source, for supplying a predetermined electric power to the light source in accordance with an input light-source controlling signal;

a display-panel driving circuit for driving the display panel in accordance with an input panel driving signal; and

a light-source controlling means for receiving the image signal and generating a signal in accordance with the level of the image signal, and for outputting the signal as the light-source controlling signal to the power source for the light source.

[Claim 2] A display device for displaying a predetermined picture image in accordance with an externally input image signal, comprising:

a light source;

a display panel for attenuating light supplied from the light source and for outputting the attenuated light;

an electric power for the light source, for supplying a predetermined electric power to the light source in accordance with an input light-source controlling signal;

a display-panel driving circuit for driving the display panel in accordance with an input panel driving signal;

a light-source controlling means for receiving the image signal and generating a signal in accordance with the level of the image signal, and for outputting the signal as the light-source controlling signal to the power source for the light source; and

an image-signal correcting means for receiving the imge signal and the light-source controlling signal, and for correcting the image signal based on the light-source controlling signal and outputting the corrected image signal as the panel driving signal to the display-panel driving circuit.

[Claim 3] A display device for displaying a predetermined picture image in accordance with an externally input image signal, comprising:

a light source;

a display panel for attenuating light supplied from the light source and for outputting the attenuated light;

an electric source for the light source, for supplying a predetermined electric power to the light source in accordance with an input light-source controlling signal;

a display-panel driving circuit for driving the display panel in accordance with an input panel driving signal;

a light-source controlling means for receiving the image signal and generating a signal in accordance with the level

of the image signal, and for outputting the signal as the light-source controlling signal to the power source for the light source;

a sensor for monitoring light output from the light source, and for outputting a detection signal; and

an image-signal correcting means for receiving the image signal and the detection signal, and for correcting the image signal based on the detection signal and outputting the corrected image signal as the panel driving signal to the display-panel driving circuit.

[Claim 4] A display device according to claim 3, wherein the image signal includes a red image signal, a green image signal and a blue image signal, and wherein the sensor is constituted by a sensor for detecting a red component, a sensor for detecting a green component and a sensor for detecting a blue component.

[Claim 5] A display device according to any one of claims 2 to 4, wherein the light-source controlling means outputs the light-source controlling signal to the power source for the light source so that the amount of light emitted from the light source is increased as the level of the image signal is increased; and wherein the image-signal correcting means corrects the image signal so that the attenuation of light at the display panel is increased as the amount of light emitted from the light source is increased.

[Claim 6] A display device according to any one of claims 1 to 5, wherein the light-source controlling means comprises:

a first filter for removing a high-frequency component from the image signal;

a maximum value holding circuit for detecting and holding a maximum value of a signal output from the first filter; and

a second filter for removing a high-frequency component from the signal output by the maximum value holding circuit.

[Claim 7] A display device according to claim 6, wherein the image signal includes a red image signal, a green image signal and a blue image signal; and wherein the maximum value holding circuit detects, then extracts and holds a maximum value from the red, green and blue image signals.

[Claim 8] A display device according to claim 6 or 7, wherein the second filter removes a frequency component that is higher than a response speed of the display panel.

[Claim 9] A display device according to claim 6 or 7, wherein the second filter removes a frequency component higher than a frame frequency of the image signal.

[Claim 10] A display device according to any one of claims 1 to 9, wherein the display device is of a direct view type

that directly displays an image on the display panel without passing the image through a screen.

[Claim 11] A method of displaying a picture image using a light source and a display panel for receiving light from the light source, attenuating the light, and outputting a picture image, comprising the steps of:

externally receiving an image signal;

detecting a maximum value for the image signal within a predetermined time;

controlling an amount of light emitted by the light source so that the amount of the light increases as the maximum value is increased; and

controlling the display panel so that attenuation of the light increases as the maximum value is increased.

[Claim 12] A display method for displaying a picture image using a light source and a display panel for receiving light from the light source, attenuating the light, and outputting a picture image, comprising the steps of:

externally receiving an image signal;

detecting a maximum value for the image signal within a predetermined time;

controlling an amount of light emitted by the light source so that the amount of the light increases as the maximum value is increased;

detecting the amount of the light emitted by the light

source; and

controlling the display panel so that attenuation of the light increases as the detected amount of the light is increased.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a display device and a display method. More particularly, the present invention relates to a display device that provides a high contrast ratio for a displayed picture image and that employs a light source having a low power consumption, and a display method therefor.

[0002]

[Description of Prior Art]

Various types of display devices have been developed as replacements for the conventional cathode ray tubes. Examples of these devices are a flat panel display fitted with a backlight, and a projection type liquid crystal display device which can provide a large screen display. As a representative example of such display devices, a liquid crystal display projection device includes a device for employing a laser beam to form a two-dimensional pattern of transmission/non-transmission on a liquid crystal display panel, and a device for employing a thin-film transistor as a switching device to electrically form a two-dimensional

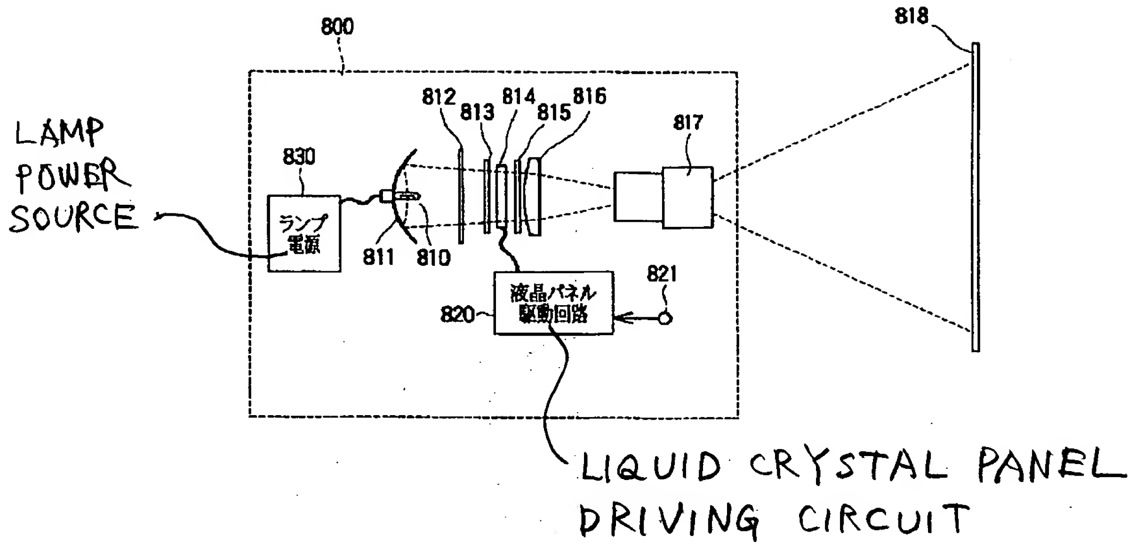
pattern of transmission/non-transmission. Liquid crystal display devices that employ liquid crystal display panels to electrically form patterns are especially expected for large-screen televisions, since those display devices can be used to display a dynamic picture. In addition to liquid crystal displays, a digital mirror display (DMD) and the like have been developed that scan micro mirrors to display a predetermined image.

[0003]

Fig. 8 is a schematic diagram showing the basic structure of a projection type liquid crystal display device employing a display panel, such as a liquid crystal panel, which operates as a light bulb. The configuration of a projection type liquid crystal display device 80 will now be described. A halogen lamp 810 fitted with a parabolic reflector 811 is provided as a light source. Also provided, adjacent to the light source, are a filter 812, an incident-side polarizing plate 813, a liquid crystal panel 814, an output-side polarizing plate 815, a field lens 816 and a projection lens 817, In addition, a power supply circuit 830, for the halogen lamp 810, and a liquid crystal panel driving circuit 820 are also provided. The liquid crystal panel driving circuit 820 is connected to and drives the liquid crystal panel 814 based on an image signal input from an external image signal source into an image signal input terminal 821. Finally, light output through the projection lens 817 forms a predetermined picture image on a screen 818.

FIG. 8

【図8】


800
818
812
813
814
815
816
817
LAMP
POWER
SOURCE
830
ランプ
電源
811
810
821
820
液晶パネル
駆動回路
LIQUID CRYSTAL PANEL
DRIVING CIRCUIT

[0004]

The operation of the above is performed as follows. Light rays emitted circumferentially by the lamp 810 are reflected to project substantially parallel light rays by the parabolic reflector 811. Thereafter, infrared and ultraviolet components of the light rays are removed by the filter 812 and a resultant white light, from which the range of unwanted, invisible wavelength components has been removed, enters the polarizing plate 813.

[0005]

The resultant white light, which is incident on the polarizing plate 813 while still retaining the emission characteristics of the lamp 810, is randomly polarized light, and is changed at the polarizing plate 813 to linearly polarized light, which thereafter enters the liquid crystal panel 814. The liquid crystal panel 814 has a structure that pixels are arranged two-dimensionally, for example, as display units in which liquid crystal, sandwiched between transparent electrodes, is driven in a 90-degree twisted nematic mode, and the polarization state of the transmitting light can be two-dimensionally modulated.

[0006]

Each pixel falls in a state of applying a weak voltage to liquid crystal in response to an image signal corresponding to the brightest display to optically rotate the polarization of the incident light 90 degrees. Similarly, in response to an image signal for a dark display, a high

voltage is applied to the liquid crystal and the rotary polarization characteristic of the liquid crystal layer does not appear, so that the incident light is emitted while retaining the linearly polarized state. Subsequently, the light emitted by the liquid crystal panel 614 is transmitted through the emission-side polarizing plate 815. At this time, a change in the polarized state of the light due to the liquid crystal panel is converted into a change in the light intensity, and as a result, the light emitted by the lamp 810 is appropriately attenuated and modulated to provide light having a two-dimensional intensity distribution. Thereafter, the resultant light is projected through the field lens 816 and the projection lens 817 onto the screen 818, whereon it forms a predetermined image.

[0007]

Most of actually used projection type display devices perform color display. The color display can thus be implemented by a color liquid crystal panel equipped with color filters. Fig. 9 is a schmatic diagram showing the arrangement of color filters for a color liquid crystal panel. Light transmitting regions, whereat filters for three primary colors, i.e., red, green and blue, are arranged, are identified by the letters R, G and B, and each set of the thus identified RGB filters constitutes a pixel 901. When the crystals of the individual RGB regions of each pixel are driven by drive voltages that respectively correspond to the intensities of the colors, the color transmittivity can be

FIG. 6

【図6】

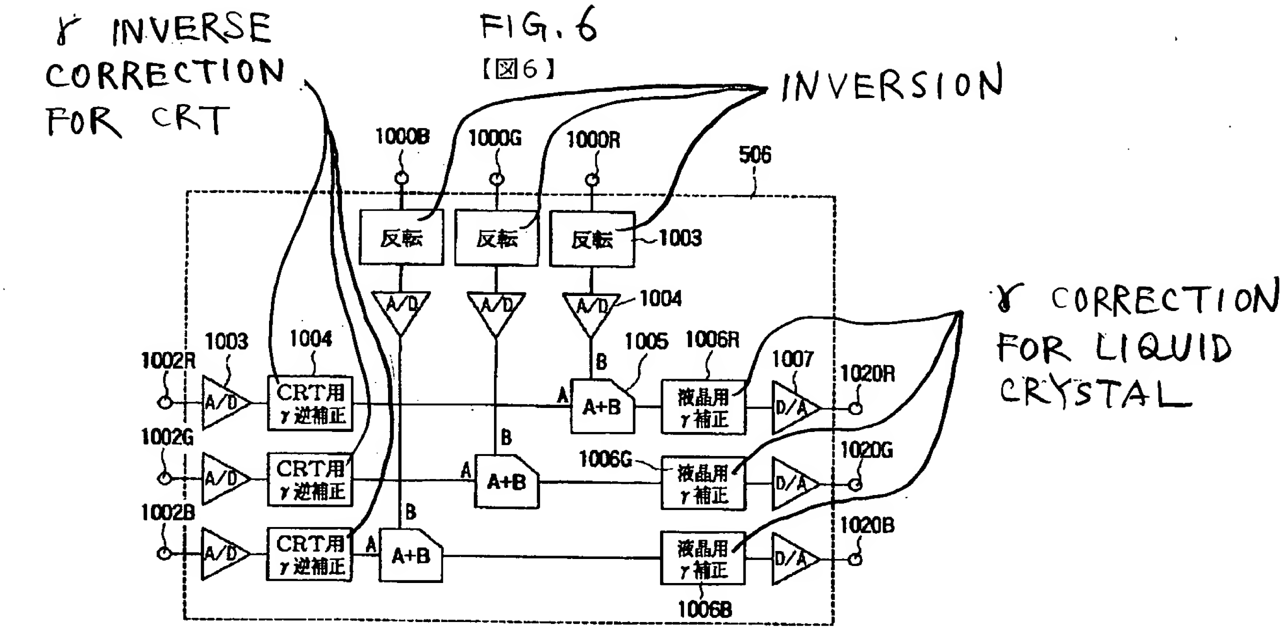


FIG. 7

【図7】

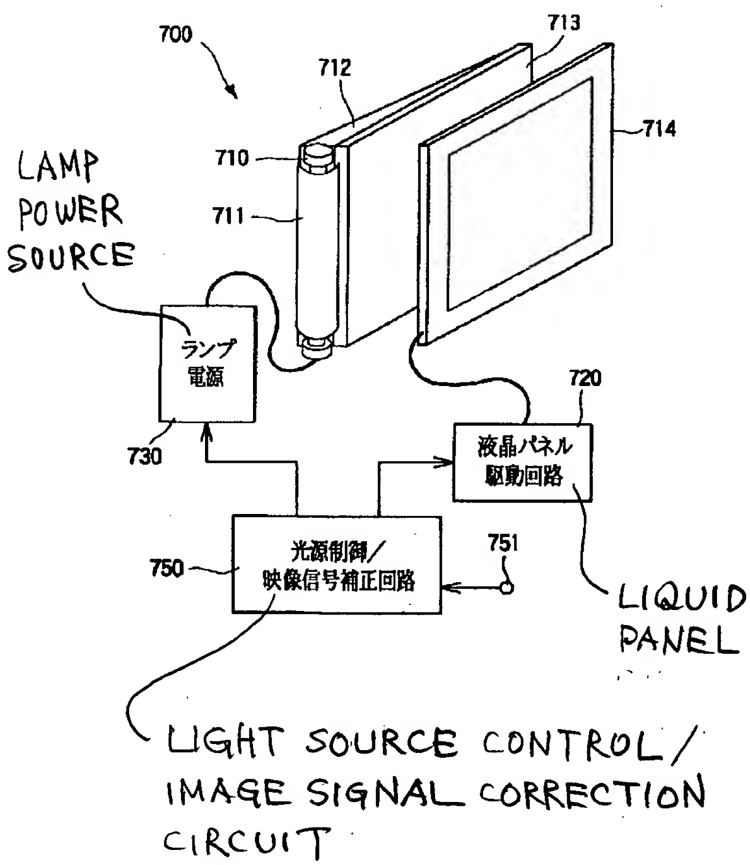
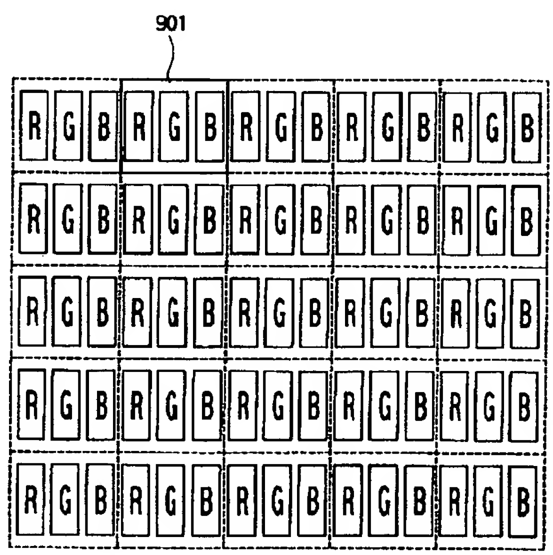


FIG. 9

【図9】



controlled. A liquid crystal panel incorporating this function is employed as the liquid crystal panel 814 in Fig. 8, and three image signals are supplied by the driving circuit 820 to corresponding R, G and B, respectively, whereby the color display can be performed.

[0008]

In addition to the above display device, a projection type display device for performing color display includes, for example, projection type display devices employing various systems as described on pages 605 to 610 of the "Liquid Crystal Device Handbook", or a device described in Japanese Patent Application Laid-Open No. 7-181487 that employs a single panel and a micro-lens to perform color display. These devices employ the same basic principle of using a lamp as a light source and modulating transitting light or reflected light by a display panel to perform color display. Furthermore, a display device is disclosed in Japanese Patent Application Laid-Open No. 63-243929 that adjusts the illuminance of a screen by detecting the light reflected by the screen.

[0009]

[Problem to be solved by the Invention]

However, a projection type display device that uses a lamp, i.e., a projection type display device that irradiates a display panel controlling transmittivity or reflectivity with light emitted from a lamp and projects the emitted light to display a picture image, has disadvantages compared with a

self-emission type picture image display device, such as a cathode ray tube (CRT), especially with respect to the following two points.

[0010]

The first point is the relationship exhibited between the brightness of a displayed image and power consumption. For a self-emission type display device, since for a dark display the energy required for light emission is reduced, the consumption of electric power is likewise reduced. However, for a device that uses a lamp, since the intensity of the light emitted by the lamp is constant regardless of the image display status, the consumption of the power is not reduced, not even for a dark display. That is, it is possible for a device employing a lamp to increase the wasteful consumption of the power.

[0011]

The second point is a difference in the dynamic range. For a self-emission type display device, the brightness of a black display can be reduced until it is near zero by reducing the intensity of the emitted light. Therefore, the device has a possibility of performing a very high contrast ratio. On the contrary, since the device using a lamp displays a picture image by attenuating the light emitted from the lamp, and since light transmittivity and light reflectivity have limitations, the contrast ratio attainable with such a display device is smaller than that which is attainable with a self-emission type display device. This

appears as a difference in the dynamic range of a screen.

[0012]

The present invention has accomplished in view of the above points. Specifically, an object of the present invention is to provide a display device having a low power consumption, a high contrast ratio and a wide dynamic range, and a display method therefor.

[0013]

[Means to solve the Problem]

Light-source controlling means is provided for varying an electric power supplied to a lamp in accordance with the brightness of a screen so that the lamp brightens as the brightness of the screen is increased and the lamp darkens as the brightness is reduced. Brightness as used here for the screen refers to the brightness of that portion of the screen that is the brightest. However, it is wasteful to simply use a very small region of a screen as the standard of a brightness, and it is preferable that the means for actually detecting a maximum value for screen brightness detect the maximum value after image signals are smoothened once by a low-pass filter.

[0014]

It is also preferable that the intensity of an image signal to be transmitted to the display panel be changed in accordance with the electric power supplied to the lamp. Further, for the color display device, it is preferable that not only the intensity of this image signal, but also the

ratio of the intensities of the image signals corresponding to the three primary colors be changed. In addition, instead of changing the image signal in accordance with the electric power supplied to the lamp, it is preferable that the light emission intensity of the lamp be detected by an optical sensor, and that a voltage applied to the display panel be changed in accordance with the amount of the emitted light. Especially for a color display device, it is preferable that a color sensor be employed, and that the ratios of the intensities of the image signals corresponding to the three primary colors which are supplied to the display panel be changed.

[0015]

[Embodiments]

According to the present invention, since the power supplied to a light source is changed in accordance with an image signal, the light emitted by the light source can be reduced for a dark screen, or can be increased for a bright screen. As a result, the contrast ratio for a displayed image can be increased and the consumption of electric power can be reduced. At the same time, the use life of a lamp can be extended.

[0016]

Furthermore, at the same time of changing the power supplied to the lamp, the intensity of an image signal supplied to the display panel is altered so that the panel darkens when the power provided to be supplied to the lamp is

greater than a constant electric power, and that the panel brightens when the power to be supplied to the lamp is smaller. Thus, it is possible to prevent a change in the brightness of the lamp from appearing unnatural on the screen.

[0017]

For many lamps, when the power to be supplied is changed, not only the brightness of the light but also the color are changed. And when the ratios of the intensities of the three primary color image signals supplied to the display panel are adjusted to compensate for a change in the color of the lamp, the brightness can be varied without the display color being altered.

[0018]

Further, the adjustment of the image signals supplied to the display panel is preferably performed not based on the power supplied to the lamp but based on the actual intensity of the light emitted from the lamp which is detected by a sensor.

[0019]

The embodiments of the present invention will now be explained while referring to the drawings. Fig. 1 is a schematic diagram showing the constitution of a projection type display device according to a first embodiment of the present invention. The optical system constitution of a display device 100 is almost the same as that of the conventional projection type display device in Fig. 8. That is, the display device comprises a halogen lamp 110, a

ように消費電力を低減することにより、投射型表示装置を低消費電力化することができる。また、本発明による直視型表示装置を用いれば、情報携帯端末などの各種携帯機器の電池寿命を延ばすこともできる。

【0056】さらに、本発明によれば、このようにランプの消費電力を低減させることにより、発熱量を低減して、画像表示装置を従来よりも小型・軽量化することが可能となる。すなわち、放熱のための対流空間や空冷装置を従来よりも簡素にすることができる。また、発熱量の低下に伴って、液晶パネルなどの光学部品あるいは電気回路部などの熱的な劣化が軽減され、長期的信頼性を改善することができる。さらに、ランプの寿命を延ばすこともできる。

【0057】本発明によれば、このように高画質で低消費電力の表示装置を提供することができ、産業上のメリットは多大である。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態による投射型表示装置の概略構成図である。

【図２】光源制御／映像信号補正回路１５０の構成を表す概略図である。

【図３】映像信号補正回路２０６の構成を表す概略図である。

【図４】本発明の第２の実施形態による投射型表示装置の概略構成図である。

【図５】光源制御／映像信号補正回路４５０の構成を表す概略図である。

【図６】映像信号補正回路５０６の構成を表す概略図である。

【図７】本発明の第３の実施形態による直視型表示装置の概略構成図である。

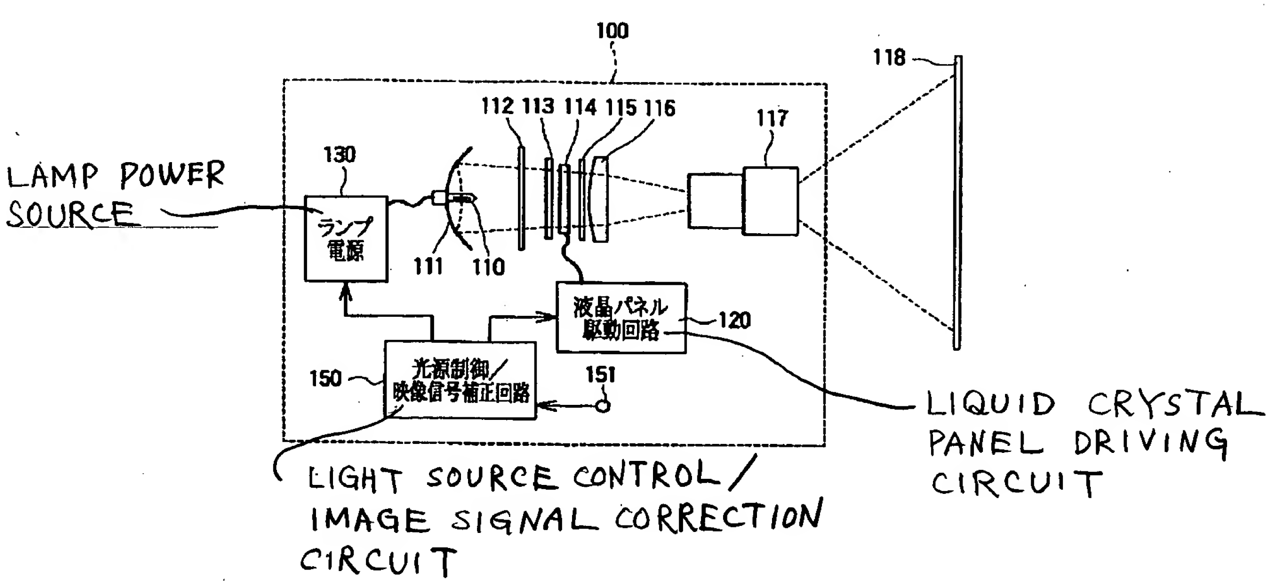
【図８】従来の反射型液晶表示装置を表す概略断面図である。

【図９】従来の表示装置の画素配列を例示する模式図である。

【符号の説明】

１００、４００、７００、８００　表示装置
１１０、８１０　ハロゲンランプ
１１１、８１１　放射面リフレクタ
１１２、８１２　フィルタ
１１３、１１５、４１３、４１５　偏光板
１１４、４１４、７１４　液晶表示パネル
１１６、４１６　コンデンサ・レンズ
１１７、４１７　投射レンズ
１１８　スクリーン
１２０、４２０、７２０　液晶パネル駆動回路
１３０、４３０、７３０　ランプ電源
１５０、７５０　光源制御／映像信号補正回路
１５１、４５１、７５１　映像信号入力端子
２０１　ＤＣ化回路
２０２、５０２　高周波フィルタ
２０３、５０３　最大値検出回路
２０４　高周波フィルタ
２０５、５０５　高周波フィルタ
２０８、５０８　光源制御回路部
２１０　ランプ電源
４１０　メタルハライドランプ
４１１　放射面リフレクタ
４１２　フィルタ
４５２Ｒ、Ｇ、Ｂ　センサ
４６１、４６２　レンズアレイ
７１０　冷陰極管ランプ
７１１　反射板
７１２　導光板
７１３　プリズムシート

FIG. 1 【図１】



parabolic reflector 111, a filter 112 for blocking infrared and ultraviolet components, an incident-side polarizing plate 113, a liquid crystal panel 114, an output-side polarizing plate 115, a field lens 116, and a projection lens 117. With these optical components, a predetermined picture image can be displayed on a screen 118.

[0020]

The feature of the display device of the present invention is to provide a light source control/image signal correction circuit 150. A liquid crystal panel driving circuit 120 drives the liquid crystal panel not based on an image signal externally supplied by an image signal input terminal 151, but on an image signal corrected by the light source control/image signal correction circuit 150.

[0021]

Further, the light source control/image signal correction circuit 150 also controls a lamp light source 130, and adjusts the power to be supplied to the lamp 110.

[0022]

Fig. 2 is a schematic diagram showing the constitution of the light source control/image signal correction circuit 150. The operation of this circuit will now be described while referring to Fig. 2. First, RGB image signals of three primary colors are input from input terminals 250R, 250G and 250B. These image signals are analog image signals having an amplitude of 0.7 V, a frame frequency of 60 Hz, 480 scanning lines, a signal band of 25 MHz and a horizontal resolution of

FIG.2

【図2】

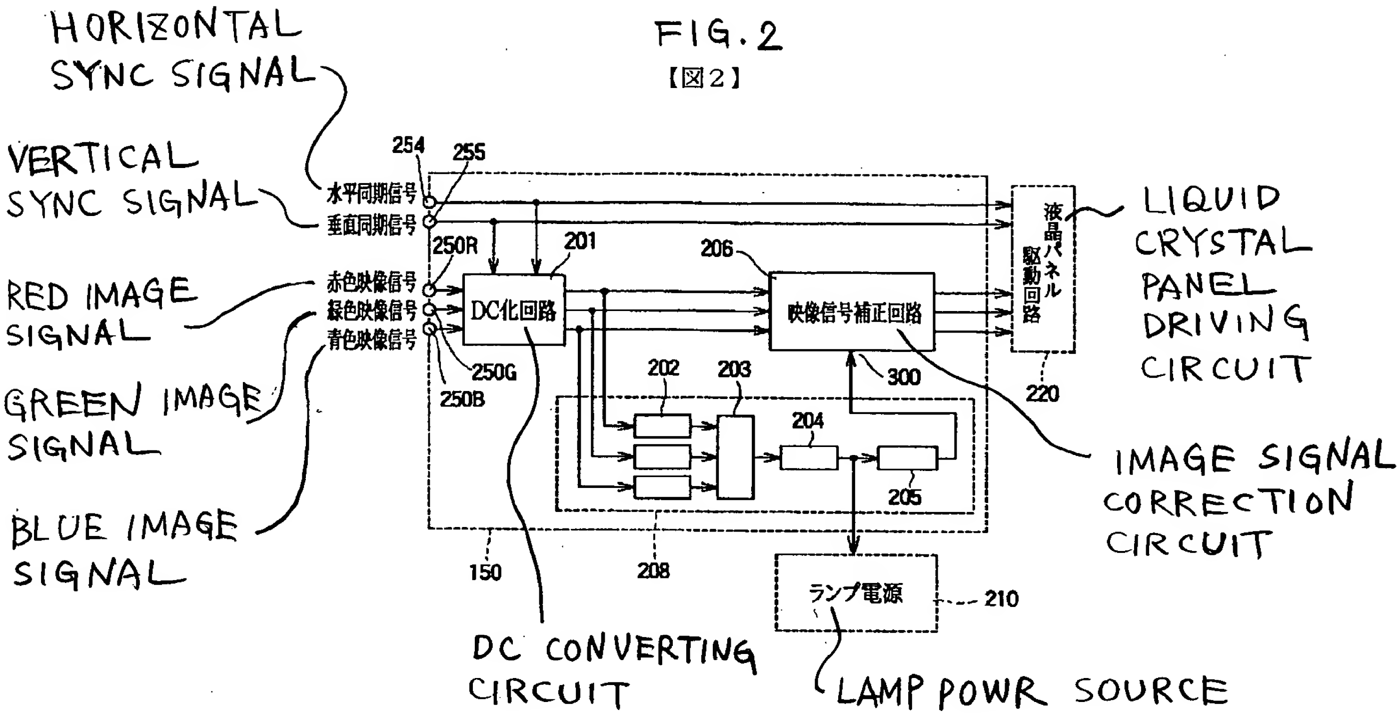
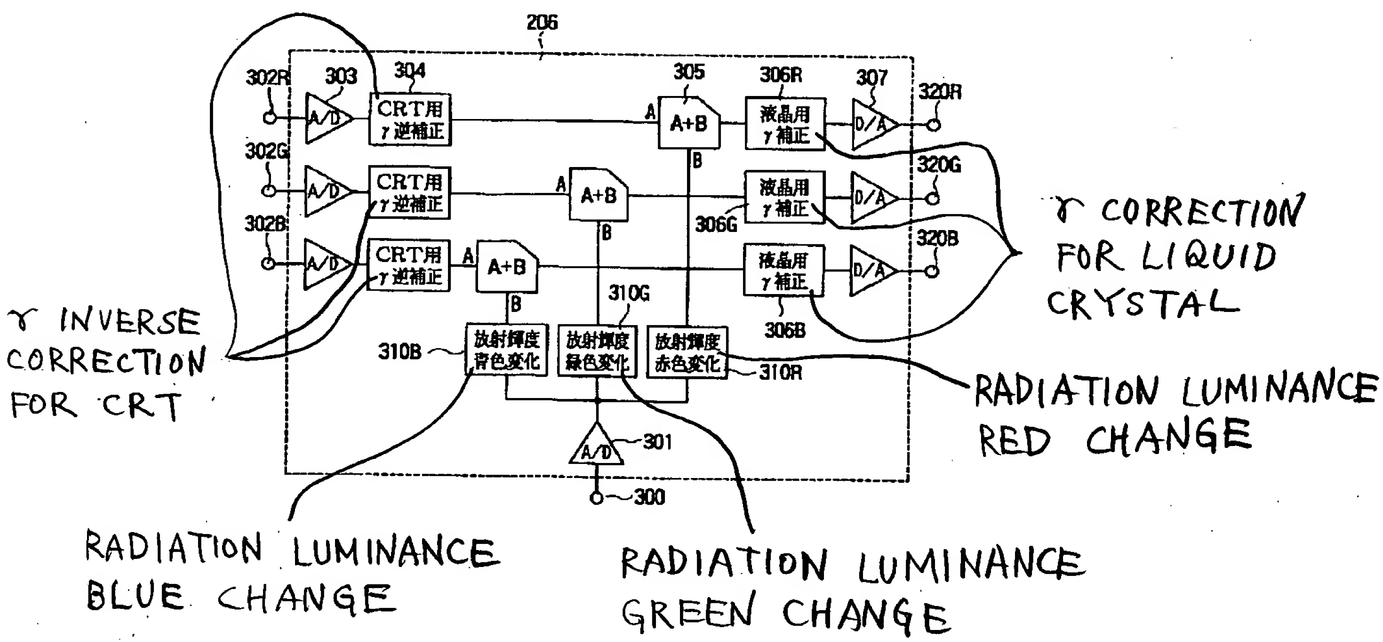


FIG.3

【図3】



almost 640 pixels. Since these input signals are AC signals, they are converted into DC signals by a DC converter 201 to facilitate their signal processing, and their amplitudes are raised to 5 V.

[0023]

The high-frequency components of the boosted image signals are removed by high-frequency cut filters 202, 202, 202 in a light-source controlling part 208. The high-frequency cut filters 202 block signal components of, for example, 8 MHz or higher, and the average intensity across a width of several pixels can be obtained spatially. Such average is obtained so as to prevent the detection of a very small luminous point and remove high-frequency noise from an image signal. Then, the maximum value among the three primary color signals is detected by a maximum value detecting circuit 203. This maximum value is employed to control a lamp light source that will be described later. The maximum value detecting circuit 203 may also detect the maximum value for any one specified color signal among the three primary color signals. In this case, it is preferable that the maximum value be detected for a green (G) signal, for which the spectral luminous efficacy of human vision is the highest, or that the sum of the values for the three primary color signals be calculated and used to detect the maximum value.

[0024]

Thus, the maximum value detecting circuit 203 holds the

detected maximum value and has a so-called peak holding function. However, if a detected maximum value is held permanently, its output will become a constant value, and for this reason an appropriate reduction circuit is required. In this embodiment, an appropriate time constant can be suitably determined for a range wherein the lower limit value is almost the same as that of the high-frequency cut filter 204 as described later, and the upper limit is a value of several seconds. A time constant that is thus determined is employed thereafter to attenuate the detected maximum value.

[0025]

After the signal output by the maximum value detecting circuit 203 is input by the high-frequency cut filter 204 and the change in the signal is moderated, the resultant signal is transmitted to the control terminal of an inverter power source 210 for a lamp. Generally, when overall the display screen is uniformly monitored, the screen may become brighter or darker. An average change in the brightness of the screen is then calculated, and is fed back to the light source. The range employed for the calculation of the average can be determined as needed in accordance with the filter band. By supplying in this manner a control signal corresponding to the maximum value of an image signal to the inverter power source 210, the lamp can be controlled so that the lamp brightens when the image signal level is high, i.e., when the screen is "bright".

Calculating the brightness of the screen

[0026]

The high-frequency cut filter 204 has a characteristic of, for example, blocking signal components of 20 Hz or higher. Therefore, only frequency components sufficiently lower than a frame frequency (60 Hz) are used for controlling the lamp power, and thereby the display correction operation of a liquid crystal panel as described later can sufficiently follow the change in the light emission intensity of the lamp. Furthermore, since a lamp appears to flicker when changes in the light emitted by the lamp occur within a short time, the high-frequency filter 204 is also used to prevent flickering.

[0027]

A signal output by the high-frequency cut filter 204 is input to the control terminal of the inverter power source 210 of the lamp, while it is input as a control signal to the image signal correction circuit 206 via the high-frequency cut filter 205.

[0028]

Fig. 3 is a schematic diagram showing the constitution of the image signal correction circuit 206. As shown in Fig. 3, the image signal correction circuit 206 corrects the voltage for driving the liquid crystal panel based on an input control signal, while it corrects a voltage correction (γ correction for liquid crystal) based on a light transmittivity for liquid crystal display.

[0029]

The operation of the above will now be described while referring to Fig. 3. In the image signal correction circuit,

three pairs of analog/digital converters 303, 303, 303 convert into digital signals the three primary color image signals as analog signals that are received at input terminals 302R, 302G and 302B. Then, a correction part 304 having a data table of γ inverse correction converts the digital signals into signals proportional to the display intensity. This is done because, since a γ correction is performed on the assumption that the normal image signal is displayed on a CRT and the voltage of the image signal is not proportional to the display intensity, it is difficult to perform a succeeding signal correction corresponding to the lamp power.

[0030]

A correction control signal input from an input terminal 300 is converted into a digital signal by an analog/digital converting circuit 301. Then, the digital signal is entered in a conversion table 310 in which the previously measured relationship between a correction control signal and the change in the light emission intensity of a lamp is recorded. As a result, a predicted value for the light emission intensity is obtained. The light emission intensity is respectively recorded for the three primary colors in luminance conversion tables 310R, 310G and 310B, and not only the luminance of the lamp but also a change in the color can be obtained. This is because the lamp used in this embodiment is a halogen lamp. Specifically, as the power is increased, the temperature of the filament, which is the light emitting

portion of the lamp, is increased and the light emission intensity is increased. At the same time, the color temperature is raised, and accordingly, the color is changed.

[0031]

From the output terminals of the three conversion tables 310R, 310G and 310B, instead of the light emission intensity, signals are output corresponding to the inverted value of the light emission intensity. Addition circuits 305, 305, 305 add these signals to the signals obtained by the γ inverse correction of the previously described image signals. By adding in this manner the image signals to the inverted values for the light emission intensity, the light of the liquid crystal panel is corrected, so that the light of the liquid crystal panel is more attenuated when the lamp is "bright", or is less attenuated when the lamp is "dark". That is, the liquid crystal panel becomes "dark" when the lamp is "bright", or becomes "bright" when the lamp is "dark". According to the present invention, since the lamp and the liquid crystal panel are so driven utilizing the inverse interaction relationship, a constant overall brightness can be maintained for the screen, and the dynamic range and the contrast ratio of the displayed image can be increased.

[0032]

The output signals of the addition circuits 305 are output to correction tables 306R, 306G and 306B. In these correction tables, the image signals are corrected so that, when image signals are input to the liquid crystal panel, the

intensities of the signals are proportional to the transmittivity in accordance with the voltage correction table based on the light transmittivity characteristic of the voltage applied to the liquid crystal panel.

[0033]

Finally, the signals output from the correction tables 306R, 306G and 306B are converted into analog signals by digital/analog converting circuits 307, 307, 307 and the analog signals are transmitted via output terminals 320R, 320G and 320B to the liquid crystal panel driving circuit 220.

[0034]

In order to compare the function of the display device of the present invention with a conventional projection type display device, the present inventor made a prototype for the projection type display device of the embodiment of the present invention and estimated images displayed when the lamp was controlled were compared with images displayed when the lamp was not controlled. As a result of this evaluation, a contrast ratio of about 200:1 was obtained for the image under the condition of not controlling the lamp, while an improved contrast ratio of about 400:1 was obtained for the image under the condition of controlling the lamp. Especially, it was found that according to the present invention a darker screen could be clearly presented at a high contrast ratio, and the image quality was drastically improved.

[0035]

In addition, according to the present invention, it was found that the power consumption of the lamp could be reduced. That is, the power consumption of the halogen lamp 110 under no lamp control was about 400 W, while the average power consumption under lamp control could be reduced to about 320 W. Since the power consumption of the lamp is particularly large for a projection type image display device, an effective power consumption reduction can be especially obtained by the application of the present invention.

[0036]

Furthermore, since the power consumption of the lamp is reduced, heat generation can be reduced and the projection type display device can be made more compactly and lighter than a conventional one. That is, an air flow space and a cooling device for heat discharge are simpler than conventional ones. Further, as heat generation can be reduced, the thermal deterioration can be reduced for optical parts, such as a liquid crystal panel, and an electric circuit part, and long-term reliability can be obtained. Moreover, the use life of a lamp can also be extended.

[0037]

A second embodiment of the present invention will now be described. Fig. 4 is a schematic diagram showing the configuration of a projection type display device according to the second embodiment of the present invention. The optical system of a display device 400 shown in Fig. 4 comprises a metal halide lamp 410, a parabolic reflector 411,

FIG. 4

【図4】

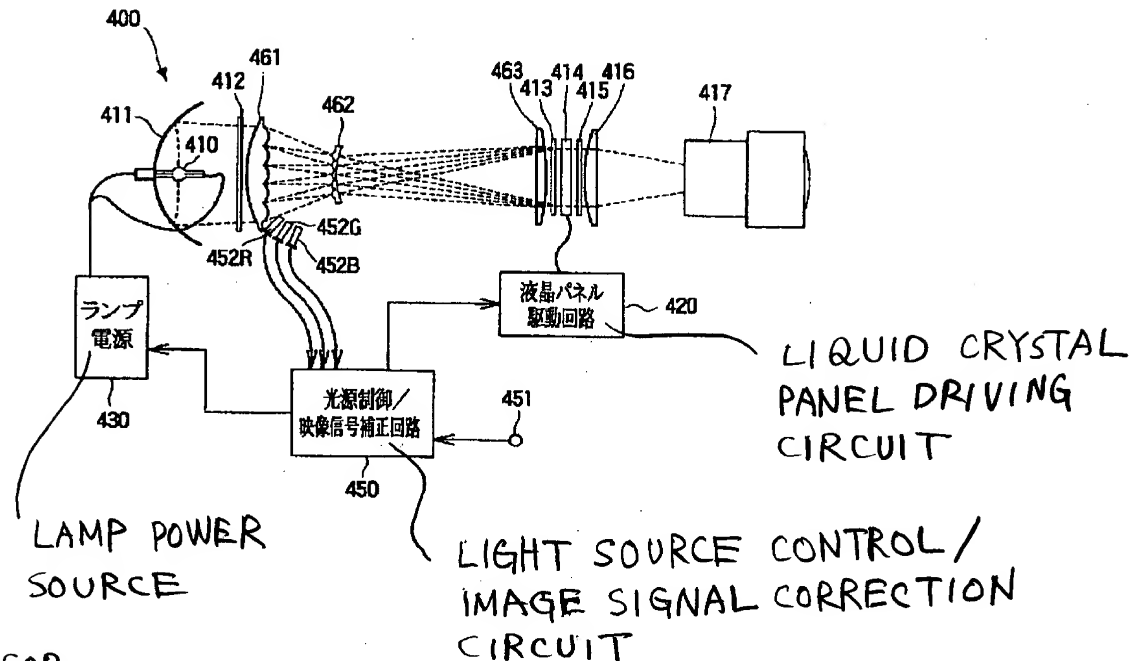
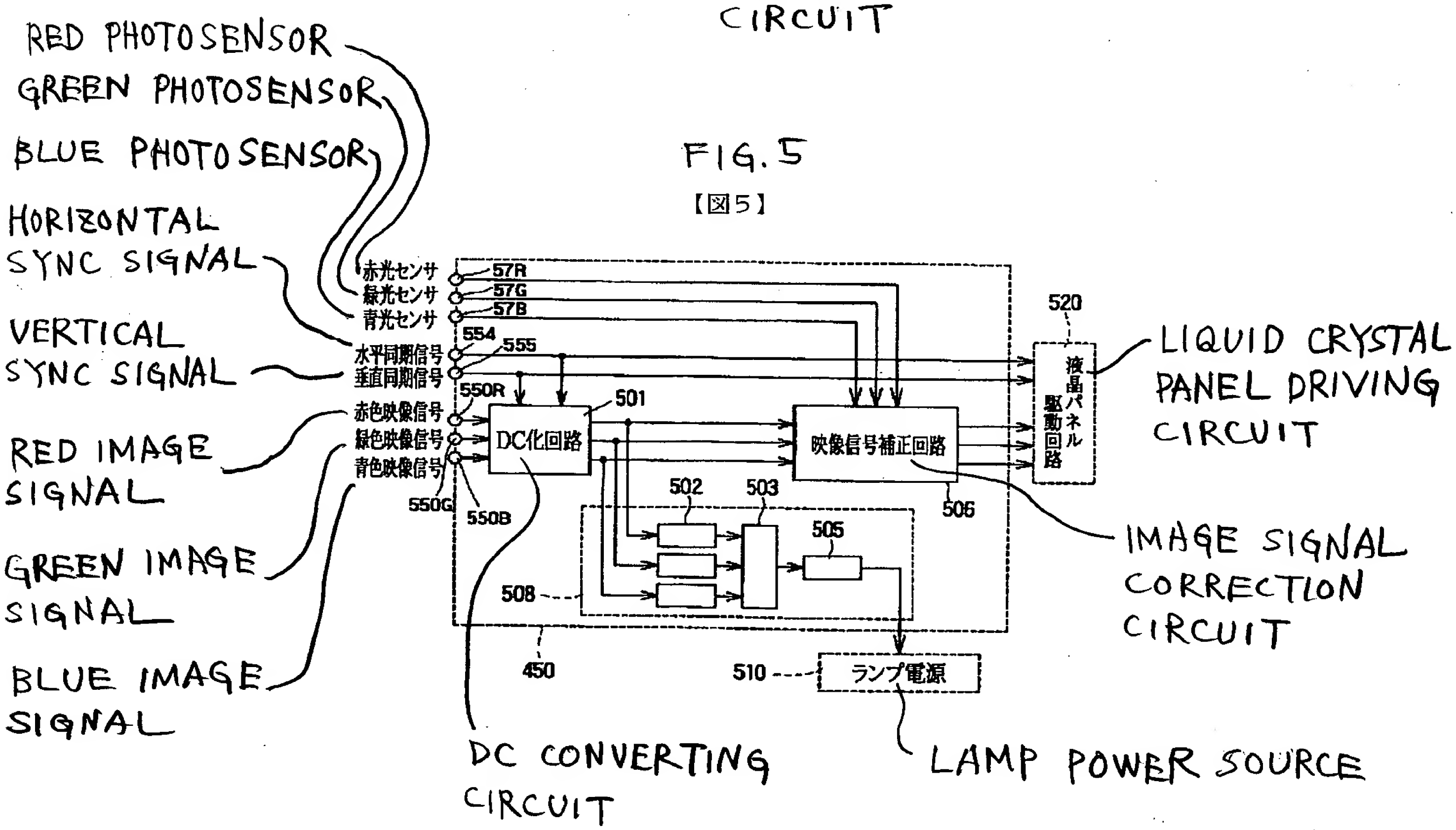


FIG. 5

【図5】



a filter 412 for blocking infrared and ultraviolet rays, lens arrays 461 and 462 for obtaining uniform illuminance, a condenser lens 463, an incident-side polarizing plate 413, a liquid crystal panel 414, an output-side polarizing plate 415, a field lens 416 and a projection lens 417. In Fig. 4, a screen is not shown.

[0038]

The different points of the optical system in Fig. 4 from the system of the first embodiment are that a metal halide lamp is employed instead of a halogen lamp, and that the lens arrays 461 and 462 and the condenser lens 463 are employed so as to provide uniform illuminance.

[0039]

A liquid crystal panel driving circuit 420 drives the liquid crystal panel 414 based on an image signal supplied from a light source control/image signal correction circuit 450. Further, based on a control signal from the lamp power/image signal correction circuit 450, a lamp power source 430 controls the power which is supplied to the lamp 410.

[0040]

Fig. 5 is a schematic diagram showing the constitution of the light source control/image signal correction circuit 450. The different point of this circuit from the light source control/image signal correction circuit in the first embodiment is that the output of a second high-frequency cut filter 505 of a light source controlling circuit part 508 is

transmitted only to the lamp power source, and instead, output signals of three photosensors 452R, 452G and 452B shown in Fig. 4 are input to an image signal correction circuit 506. Therefore, in appearance, the correction of an image signal and the control of the lamp power are performed independently. Actually, however, in this embodiment the correction of an image signal is performed in association with the lamp power control. This is because the image signal correction circuit 506 detects the brightness of the lamp 410 with the optical sensors 452, and controls it.

[0041]

Fig. 6 is a schematic diagram showing the constitution of the image signal correction circuit 506. The operation thereof will now be described. Image signals of the three primary colors as analog signals input from input terminals 1002R, 1002G and 1002B, are converted into digital signals by analog/digital converting circuits 1003, 1003, 1003. Then, in accordance with the data tables for γ inverse correction 1004, 1004, 1004, the digital signals are converted into signals proportional to the display intensity. This operation is the same as that performed by the image signal correction circuit 206 shown in Fig. 3.

[0042]

Following this, light intensity signals from the photosensors 452R, 452G and 452B are input to the three input terminals 1000R, 1000G and 1000B. The photosensors 452R, 452G and 452B respectively include red, green and blue color

filters, and can detect the intensities of light beams corresponding to the three primary colors. These photosensors are arranged in the direction of the lens array 462 as is shown in Fig. 4, so as to detect light which is slightly irregularly reflected when the light emitted from the lamp 410 passes through the lens array 462. The importance in this case is that the light nearer the lamp than the liquid crystal panel is detected along the light path in order to measure the brightness of the lamp without being substantially affected by the display state of the liquid crystal panel 414.

[0043]

The intensity signals of the three primary colors of the lamp, which are input by the photosensors to the image signal correction circuit 506, are converted into signals having an inverted light intensity by inversion amplifiers 1003, 1003, 1003 and a lower voltage as the light intensity is increased. Amplification rates can be set for the individual inversion amplifiers 1003, so that the amplifiers can correct the sensitivity of each photosensor which differs depending on the color. The outputs of the inversion amplifiers are converted into digital signals by analog/digital converting circuits 1004, 1004, 1004 and the succeeding signal processing is performed in the same manner as for the image signal correction circuit shown in Fig. 3. The digital signals are added to image signals by adders 1005, 1005, 1005 and the obtained signals are input to the liquid crystal

panel by voltage correction tables 1006R, 1006G and 1006B, which are based on the light transmittivity characteristic for the voltage applied to the liquid crystal panel. At this time, the signals are corrected so that the intensity of each image signal is proportional to its transmittivity. Finally, the digital signals are converted into analog signals by digital/analog converting circuits 1007, 1007, 1007 and the analog signals are output via signal terminals 1020R, 1020G and 1020B to the liquid crystal panel driving circuit 520.

[0044]

For comparison with the function of the conventional projection type display device, in this embodiment, the present inventor manufactured a prototype for the projection type display device, and evaluated these devices when the lamp was controlled and when the lamp was not controlled. As a result, as in the previous case, it was found that while the contrast ratio without lamp control was about 200:1, the contrast ratio under lamp control could be improved to about 400:1. Especially in this embodiment, it was found that since a clear display can be presented at a high contrast ratio and the change in the color temperature due to the control of the light quantity of the lamp can be fed back, color reproduction is extremely satisfactory, both for a bright screen and a dark screen.

[0045]

Further, according to the present embodiment, since the light emission spectrum of the lamp can always be monitored

by the photosensor, the change in the color temperature that is accompanied by a transient change in the lamp can be also detected and fed back. Therefore, a color change of the displayed image due to the deterioration of the lamp can be prevented.

[0046]

Furthermore, also in the present embodiment, it was confirmed that the power consumption of the lamp is reduced. That is, when lamp control is not performed, the power consumption of the metal halide lamp 410 is a constant value of about 250 W, while the average power consumption under lamp control can be reduced to about 190 W. As in the previous embodiment, various effects can be obtained by the reduction of the power consumed by the lamp.

[0047]

A third embodiment of the present invention will now be described. Fig. 7 is a schematic diagram showing the constitution of a direct view type display device. A display device 700 shown in Fig. 7 comprises a cold cathode tube lamp 710 which is a light source, a reflecting plate 711, a light guide plate 712, a prism sheet 713 and a liquid crystal panel 714. Polarizing plates are attached to both sides of the liquid crystal panel 714.

[0048]

Light emitted from the lamp 710 is reflected by the reflecting plate 711, and the reflected light is guided to the light guide plate 712. The light entering the light

guide plate 712 is passed through the inside, and is appropriately scattered toward the prism sheet 713. As a result, light is fed almost uniformly to the prism sheet 713. After the directions of these light beams are adjusted by the prism sheet, the light beams are transmitted to the liquid crystal panel 714, and are attenuated to a predetermined level to form a predetermined image.

[0049]

In this embodiment, similarly as in the first embodiment, the electric power to be supplied to the lamp 710 and the signal to be input to the liquid crystal panel 714 are controlled by a light source control/image signal correction circuit 750. Further, also similarly as in the second embodiment, photosensors (not shown) may be provided near the lamp 710 or the light guide plate 713, so that while light from the lamp is monitored as needed, the data of the light from the lamp may be fed back. Also in this embodiment, by correcting the circuit 750, when an image signal corresponds to a bright screen, the lamp power is increased with the light attenuation of the liquid crystal panel being made large; or when the image signal corresponds to a dark screen, the lamp power is decreased with the light attenuation of the liquid crystal panel being made small. As a result, the certain brightness of the overall screen is maintained, the contrast ratio of a displayed image is improved, and a clearer image than the conventional image can be obtained.

[0050]

In addition, in this embodiment, the power consumed by the lamp can also be reduced. The direct view type display device shown in Fig. 7 is employed especially for portable devices, such as a notebook type computer and a personal digital assistant (PDA). For these portable devices, the increase in the service life of an incorporated battery is an extremely important technical matter. Therefore, the reduction of the power consumed by the light source of the display device in this embodiment can be extremely effective.

[0051]

In the above-described embodiments, the display devices using a liquid crystal panel as a display panel have been employed. However, the present invention is not limited to these display panels. That is, the present invention can be applied for all other display devices that employ a light source and display a predetermined picture image by attenuating the light emitted by the light source, and the same various effects can be obtained. For example, the present invention can be applied in the same manner for a display device employing a digital mirror device as a display panel.

[0052]

[Effects of the Invention]

The present invention is implemented in the above-described embodiments, and provides the following effects.

[0053]

First, according to the present invention, a clear

picture image can be displayed at a high contrast ratio. That is, while the contrast ratio of a conventional display device is about 200:1, the contrast ratio for the present invention can be improved to about 400:1.

[0054]

According to the present invention, a darker picture image can be clearly displayed, especially on a dark screen at a high contrast ratio, and the image quality can be drastically enhanced.

[0055]

Further, according to the present invention, the electric power consumption of the lamp can be reduced. That is, the power consumption of the lamp can be reduced to approximately 80% or less of the conventional power consumption of the lamp. Since the power consumption is thus reduced, the power consumption of the projection type display device can be made lower. Furthermore, when the direct view type display device of the present invention is employed, the battery life of a portable device such as a PDA can be extended.

[0056]

In addition, according to the present invention, since the power consumption of the lamp is thus reduced, the amount of generated heat can be reduced, and an image display device can be made more compact and lighter than a conventional device. That is, an air streaming space and a cooling device for heat discharge can be simplified. Further, since the

amount of generated heat is reduced, the thermal deterioration of optical parts, such as a liquid crystal panel, or electric circuits, can be reduced, and long-term reliability can be obtained. Moreover, the service life of the lamp can be extended.

[0057]

According to the present invention, a display device having a high picture image quality and a low power consumption can be provided with great industrial merits.

[Brief Description of the Drawings]

[Fig. 1]

It is a schematic diagram showing the constitution of a projection type display device according to the first embodiment of the present invention.

[Fig. 2]

It is a schematic diagram showing the constitution of a light source control/image signal correction circuit 150.

[Fig. 3]

It is a schematic diagram showing the constitution of an image signal correction circuit 206.

[Fig. 4]

It is a schematic diagram showing the constitution of a projection type display device according to the second embodiment of the present invention.

[Fig. 5]

It is a schematic diagram showing the constitution of a

light source control/image signal correction circuit 450.

[Fig. 6]

It is a schematic diagram showing the constitution of an image signal correction circuit 506.

[Fig. 7]

It is a schematic diagram showing the constitution of a direct view type display device according to the third embodiment of the present invention.

[Fig. 8]

It is a schematic cross-sectional view of a conventional reflection type liquid crystal display device.

[Fig. 9]

It is a schematic diagram showing the pixel array of a conventional display device.

[Description of Reference Numbers]

100, 400, 700, 800: display device

110, 810: halogen lamp

111, 811: parabolic reflector

112, 812: filter

113, 115, 413, 415: polarizing plate

114, 414, 714: liquid crystal display panel

116, 416: condenser lens

117, 417: projection lens

118: screen

120, 420, 720: liquid crystal panel driving circuit

130, 430, 730: lamp light source

150, 750: light source control/image signal correction circuit

151, 451, 751: image signal input terminal

201: DC converting circuit

202, 502: high-frequency filter

203, 503: maximum value detecting circuit

204: high-frequency filter

205, 505; high-frequency filter

208, 508: light source controlling circuit part

210: lamp power source

410: metal halide lamp

411: parabolic reflector

412: filter

452R, G, B: sensor

461, 462: lens array

710: cold cathode tube lamp

711: reflection plate

712: light guide plate

713: prism sheet